OVERVIEW OF THE ISS RUSSIAN SEGMENT RESEARCH AND FACILITIES

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International Space Station (ISS)

ISS is important phase of human space exploration

More than 20 years of PERMANENT human residence in space

Demonstration of international cooperation capabilities

Advanced technology maturation

Unique scientific laboratory
Completion of the ISS development – beginning of full-scale utilization, 2010

- Bi-axial pointing platform with hyper-spectrometer
- Multilayer scintillation spectrometer «Alpha-electron»
- «Photon-Gamma» apparatus
- Plasma-wave apparatus «Obstanovka»
- Radiometric sounder PK-21-8
- Plasma-wave diagnostic device «Seysmoprognoz»
- Plasma-wave apparatus «Obstanovka»
- Instrument for sky monitoring (MVN)
- High-speed data transmitter
Completion of the ISS development – beginning of full-scale utilization, 2011-2014

- Universal workstations inside (16) and outside (13) will be mounted
- Payload pressurized volume about 6 м³, power capability of 2,5 kW (enabling of experiments with electric furnaces)
- ERA arm and automated airlock
- New universal facilities and tools (multizone furnace, spectrophotometers, vibro-protecting and pointing platforms, glove box, thermostats etc.)
MLM payloads

- Multizone electrovacuum furnace
- Window payload interface
- Automatic vibro-protective revolving platform
- Thermostats for bio-research
- Universal workstations
- Vacuum workstation
- Glove box
- Universal workstations
Future research capabilities of the RS ISS

- MLM will support approximately 40% of the total amount of experiment planned for the ISS RS

- Two scientific and power supply modules of about 15 kW each by 2015. This provides fully independent power supply of RS ISS

- Data relay system based on «Luch» relay satellites (up to 300 Mbps).

- Starting from 2016 Russia plans also to use for experiments automatic spacecraft “OKA-T” maintained at the periodical docking with ISS.

- In total, the plans call for 8 modules of the ISS RS by 2015, with total power capability of 30 kW and the payload pressurized volume about 40 cubic meters.

**Long-term Research Program:**

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Zarya | Zvezda | Pirs | | | | | | | | | | | | RS ISS assembling 1 stage

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Zarya | Zvezda | Pirs | | | | | | | | | | | | RS ISS assembling 2 stage

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Zarya | Zvezda | Pirs | | | | | | | | | | | | RS ISS assembling 3 stage
About 130 units of scientific equipment of about ton total mass are housed on the ISS RS.

Hundreds of scientists are involved in the scientific program from more than 40 organizations.

Much more room will be available in the next few years for additional experiments.

103 Russian space experiments were conducted by 2011.

39 space experiments are completed (>6,000 scientific sessions).

64 experiments are carrying out, 86 experiments are being prepared;

Results were presented in more than 650 scientific articles and reports;
Areas of the research results implementation

Fundamental sciences

Applied sciences

Future exploration technologies
Health care in the long flights on the ISS, experiments for future flights to the other planets.
Study of mechanisms of biological adaptation to space flight conditions (weightlessness, radiation, artificial habitat).
30 experiments were implemented

Some results of these medical research are also applicable in clinical practice on Earth.
The future missions to the Moon and Mars will be much more difficult and fully autonomous which requires even increasing safety and efficiency of medical care.
Crystallizer: High quality protein crystals growth.

Nonlinear waves in plasma crystal

SHS: Self propagating High-temperature synthesis of different high-melting inorganic materials. Results can be used for repair works in space and building on other planets

For the next decade:

- High quality crystals growth semiconductors, metals and dielectrics by different methods with multizone furnace:

- Fluid and transport physics, low temperatures:

«Ekran-M» experiment: Synthesis of semiconductor multilayer heterostructures in space vacuum \( p < 10^{-12} \) mm Hg by Molecular Beam Epitaxy technology behind the molecular shield could improve nano-electronics, in particular raising the efficiency of solar cells as much as 60%.
Geophysics

Study of geophysical processes from outer space, including the processes in the upper atmosphere and near-Earth space environment.

8 research programs were implemented.

- **Vsplesk facility preparation (Inc.#17)**
- **Experiment Vsplesk:** development of earthquake forecasting methods with the precursor-bursts of high-energy charged particles in the near-Earth space.
- **Experiment Relaxation:** Study of atmospheric optical phenomena on the orbital altitudes.
- **Study of thunderstorms activity**

For next decade:

- Physics of atmosphere and ionosphere.
- Plasma physics and space weather effects.
- Study of disaster (earthquakes, climate change etc.) forecasting methods and precursors.
New methods and tools for the Earth observation and ecological monitoring from space.

5 research programs were implemented

Monitoring of ocean bioproductivity for research and fishing needs.

For next decade:

Optical study of the atmosphere – land and ocean system.

Radiometry experiments
Biotechnology

Study of the biological and biotechnological processes in space, development of basic technologies for manufacturing of bio-products under microgravity conditions.

24 experiments were implemented

- Search for AIDS, Hepatitis-B vaccine, anticancer drugs
- Diagnostic systems and immunomodulators
- Fungi strains: remedies and stimulators of plant growth
- The effective bacterial forms for oil biodegradation

For next decade:

- Study of influence of space conditions on the cultivated strains, cells and intercellular environment.
- Development of bioreactors, biospecific sorbents, methods and tools for bioproduct detection and other equipment for various strain cultivation and bioproducing.
- And much more investigation for next generation medicine (vaccines, drugs and strains).
Space technologies

The development of space technique, technologies, energy systems and their application to the research on ISS RS and for further space exploration.

Study of physical conditions in the ISS orbit and its impact on the safety of the crew, space equipment and materials. **26 experiments were implemented**

For next decade:

- Increase the efficiency and safety of space exploration, ISS resource prolongation. New methods and technologies to find leaks, disruptions, corrosion points, protection against radiation and other negative factors of space.
- Development of new technologies for preservation of Earth’s ecosystem, by removing from the surface those power-consuming and waste-producing industries, in particular energy generation industry, for instance:
  - **Znamya** experiments – testing of large-scale thin-film construction deployment in space
- Automation and robotization of the space activity.
- Exploration systems
Solar system and astrophysics investigations

Sun, planets and small bodies of the Solar system.
Study of the interplanetary matter on board the ISS by contact methods (mass spectrometric, physical and chemical methods of analysis of near-Earth space dust).
The structure of the Universe and processes outside the Solar system and associated fundamental physical problems.

2 research programs were implemented

**Platan** experiment: Study of iron group nuclei in galactic cosmic rays and ions in solar cosmic rays. Detection of micro-particles around the ISS.

**BTN-neutron** experiment: Studying of charged and neutral particles during Solar Particle Events; detecting of Gamma Ray Bursts “simultaneously” with HEND/Mars Odyssey for interplanetary triangulation;

**For next decade:**

Solar system investigations:
- **Planet monitoring** (study of planet’s surface, atmosphere, clouds; exoplanets, debris and asteroids)
- **Dust and microparticle detector.**

Astrophysical experiments:
- **KLPVE** – study of ultra high energy particles >10^{19}eV
- **MVN** – all the sky monitoring in X-rays
- **Lira-B** – high precision photometrical and coordinate measurements
The experiment results are stored in the Roscosmos data bank.
International cooperation

**ESA**

Upon the Frame Agreement signed Joint Experimental Program is enforced

*In the first line*
- Plasma crystal
- Matroschka
- Relaxatsiya (ATV-reentry)
- Dal’nost’ (GTS-2)

*In the second line*
- Bars (Lipidis)
- Display (Pasta)
- VIPIL
- Peritektika (Parsec)
- DSMIX
- VILMA
- … about 10 experiments
- Dozens of experiments in future

**JAXA**

Russian Crystallizer experimental program has been joined with PCG experiments on Japan Protein Crystallization Research Facility

*Scientific protocols of Aquarium-AQH and Matroschka-P experiments have been signed.*

Investigation of Medaka fish in Aquarium-AQH

Matroschka-P - Padles

**NSAU**

The Program of Scientific & Applied Experiments has been updated in framework agreement between Roscosmos and State Space Agency of Ukraine.

**CSA**

One experiment is carried out, another is planned

**NASA**

Suggestions on possible areas of future scientific collaboration with NASA are being discussed
Conclusions

International space station has become a symbol of intellectual potential of humanity.

ISS is a unique space laboratory for conducting fundamental and applied research, preparation for the further exploration of the solar system.

Fully utilizing of the ISS by international partners will give us many new exciting results.